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Preliminary

Viscoelastic Relaxation of Chemically Treated Woods*[1]

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This paper deals with the viscoelastic relaxation for four kinds of chemically treated wood.

Figure 1 illustrates the dynamic modulus and the loss tangent along the grain at 11 Hz as functions of temperature for dry untreated and treated spruce *(Picea sitchensis)* specimens. Three types of relaxation, being labelled α_U to γ_U in order of decreasing temperature, were detected in the untreated wood. These α_U to γ_U relaxations are respectively attributed to the micro-Brownian motion of the main chains in the non-crystalline region, the motion of the adsorbed water molecules and the motion of the CH_2OH groups.

Three relaxations of α_F to γ_F were observed for the formaldehyde-treated wood (WPG: 4.6%). This treatment involves the crosslinking of chains by OCH_2 bridges. The micro-Brownian motion of the main chains may be restricted to some extent by this crosslinkage, resulting in a lowering of the α_F loss. The β_F peak was slightly lower compared to the β_U peak, which can be ascribed to the reduction in hygroscopicity of the treated wood. The γ_F peak was slightly higher than the γ_U peak. This treatment reduces the OH group and increases the OCH_2 group. The OCH_2 peak was observed in almost the same temperature range in the cellulose derivatives with this group. Therefore, this relaxation may involve both the motions of the remained CH_2OH groups and the introduced OCH_2 groups.

The acetylated wood (WPG: 20.3%) had two relaxations of α_A to β_A. In this treatment hydrophilic OH groups are substituted with hydrophobic and bulky $COCH_3$ groups. The introduction of the bulky $COCH_3$ group may reduce the cohesive forces between the main chains. Thus, the modulus decreased and the loss increased remarkably above 100°C. The β_A peak temperature was observed between the β_U and γ_U peak temperatures. The β_A location was close to the peak temperature due to the $COCH_3$

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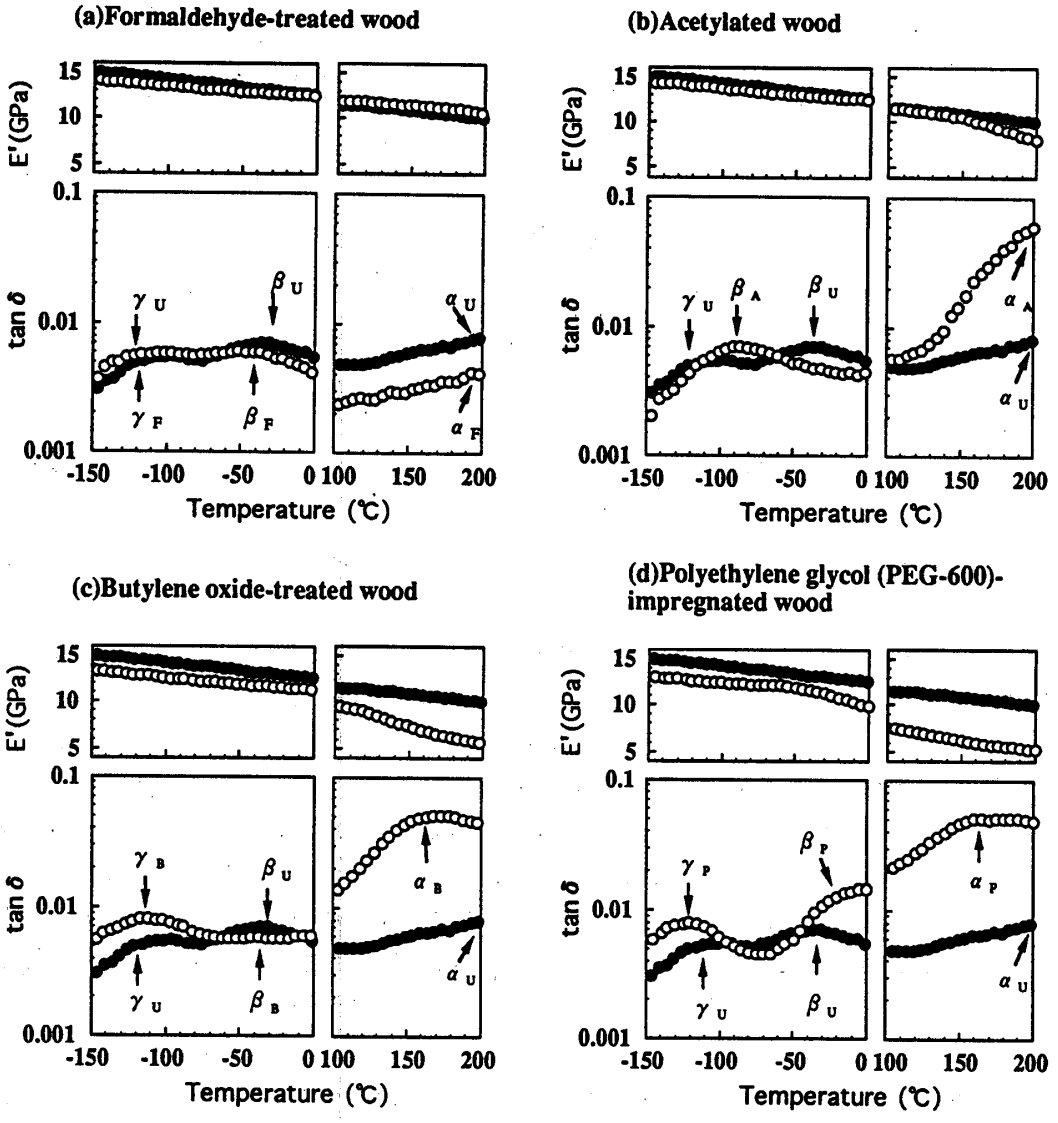

Fig. 1. Dynamic modulus E′ and loss tangent tan δ along the grain at 11 Hz plotted against temperature for dry untreated (●) and chemistry treated (○) woods.

groups in acetylcellulose. This relaxation is probably due to the motion of the $COCH_3$ groups.

For the butylene oxide-treated wood (WPG : 25.1%) three relaxations of α_B to γ_B were detected. This treatment results in bonded cell-wall bulking as in the case of acetylation except that the introduced groups are hydrophilic. The α_B relaxation due to the micro-Brownian motion of the main chains exhibited a marked peak within the temperature range examined. A considerable lowering of the peak temperature and the loss increase by this treatment could be ascribed to the introduction of flexible bulky groups in the main chains. The treatment reduces the hygroscopicity of wood at low relative humidity levels, so that the β_B relaxation due to the absorbed water became less distinct. The treatment reduces the

CH_2OH groups and increases the OCH_2 groups. The γ_B peak occurred at the same temperature as the corresponding peak for the cellulose derivatives with the OCH_2 group. Therefore, the motions of the OCH_2 groups may be responsible for this relaxation.

Three relaxations of α_P to γ_P were detected in the polyethylene glycol (PEG-600)-impregnated wood (WPG: 49.7%). A considerable lowering of the α_P peak temperature could be ascribed to the plasticization of the cell wall by the PEG molecules. The β_P relaxation appeared by the introduction of the PEG molecules and may be due to their macro-Brownian motion. The γ_P peak was rather large and its location shifted apparently to a lower temperature to the γ_U peak. Therefore, this relaxation can involve the segmental motion of the PEG molecules as well as the motion of the CH_2OH groups.